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A. D. MELVIN, CHIEF OF BUREAU.

# LIP-AND-LEG ULCERATION OF SHEEP.

## I. THE WORK OF THE BUREAU OF ANIMAL INDUSTRY FOR THE SUPPRESSION OF LIP-AND-LEG ULCERATION OF SHEEP.

BY

A. D. MELVIN, D. V. S.,
*Chief of the Bureau of Animal Industry*

## II. LIP-AND-LEG ULCERATION (NECROBACILLOSIS) OF SHEEP: ITS CAUSE AND TREATMENT.

BY

JOHN R. MOHLER, V. M. D.,
*Chief of the Pathological Division.*


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# LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
*Washington, D. C., February 21, 1910.*

SIR: I have the honor to transmit herewith two papers, dealing with the disease known as lip-and-leg ulceration of sheep, which were presented respectively by myself and Dr. John R. Mohler, Chief of the Pathological Division of this Bureau, before the convention of the National Wool Growers' Association at Ogden, Utah, January 8, 1910.

As this disease has become so serious in some localities in the West as to necessitate a federal quarantine, and as these papers contain information which will enable sheep raisers to apply measures of prevention and treatment, I respectfully recommend that they be published together as a circular of this Bureau.

Respectfully,

A. D. MELVIN,
*Chief of Bureau.*

Hon. JAMES WILSON,
*Secretary of Agriculture.*

# LIP-AND-LEG ULCERATION OF SHEEP.

## I. THE WORK OF THE BUREAU OF ANIMAL INDUSTRY FOR THE SUPPRESSION OF LIP-AND-LEG ULCERATION OF SHEEP.

By A. D. MELVIN,
*Chief of the Bureau of Animal Industry.*

For many years there have existed in the United States a group of diseases of an ulcerative nature affecting animals of various species and attacking various parts of the body. These affections, which have been known by such names as foot-rot, necrotic dermatitis (or inflammation of the skin), necrotic stomatitis (or sore mouth), and other terms, have been found by scientific investigation to be due to one and the same germ, known as the necrosis bacillus; consequently they have been grouped under the general designation of necrobacillosis, and may be considered as a single disease manifesting itself in various forms.

The Bureau of Animal Industry had occasion to study this disease as long ago as 1902, and during the period since that year it has made careful investigations and studies of various forms occurring in different species of animals. An article on foot-rot of sheep and another dealing in general with the necrosis bacillus were published in the Bureau's annual report for 1904, and a bulletin was issued in 1905 with special reference to the forms known as calf diphtheria and sore mouth in pigs. In 1906 an importation of Swiss goats was found affected with a disease which it was at first feared might be foot-and-mouth disease but which proved on investigation to be necrobacillosis, and an opportunity was thus afforded for a study of the disease at that time.

Until recently the nature of the disease in the United States in most instances has been mild, but within the past year or two it has assumed a malignant form among sheep in Wyoming, Montana, and some of the other Western States, where it has especially affected the lips and legs of the animals (and in many cases the genital organs), and has received the name of lip-and-leg ulceration.

It is my purpose at this time to discuss the nature of the disease only in a general way, and to discuss more especially the situation in

the Western States during the past year or more and the steps taken by the Bureau of Animal Industry to suppress the disease. The technical side of the subject is presented in the accompanying paper by Dr. John R. Mohler, chief of the Pathological Division of the Bureau.

The first information received by the Department of Agriculture indicating the serious character that the disease had assumed among sheep in the Northwest was conveyed in a telegram of November 23, 1908, in which it was stated that there was a serious outbreak of what was called foot-and-mouth disease in three counties of Wyoming, and asking that the Bureau send an expert to make an investigation so that proper steps might be taken to deal with the trouble. This report, coming at a time when we were engaged in combating an outbreak of foot-and-mouth disease in the East, and when it was not known how far the contagion of that disease might have spread, caused grave apprehension that foot-and-mouth disease might have reached the range country of the West, where it would have been a much more difficult and serious problem. I therefore took immediate steps to have the disease in Wyoming investigated, and within a week reports had been received from two of our inspectors, Drs. R. H. Treacy and E. J. Cary, to the effect that the disease was of a necrotic nature and not foot-and-mouth disease. It is hardly necessary to add that this information was very gratifying and relieved the fear that had been felt.

It appeared, however, that the disease affecting sheep in Wyoming was really a serious matter, so a number of additional men were sent by the Bureau to examine flocks at different places and to make a careful and thorough examination and study of the disease. Large numbers of specimens were sent to the pathological laboratory at Washington and were there examined by scientific methods that could not be used in the field.

The result of these further investigations confirmed the diagnosis already made and left no doubt that the disease was a malignant form of necrobacillosis. Attention was then directed to the study of methods of treatment, and steps were taken to disseminate information as to the character of the disease and the measures that should be taken to cure it and prevent its spread.

In the early period of the outbreak the Department recommended that affected animals be segregated and given careful treatment by hand with proper disinfectants. This seemed to most sheep owners to be an impossible method of procedure, on account of the large number of animals affected and probably also because such treatment was so different from and so much more difficult than any method that they had ever before been obliged to use in handling their sheep. It should be understood that at this time there had been no work

done looking to the treatment of large bands of sheep running upon the open range. The next expedient resorted to in this emergency was the dipping in an antiseptic solution of the exposed sheep and those but slightly affected, with the expectation that this might check the disease and cure these slight cases. This treatment, however, seems in many instances not to have met with the success that was expected of it, and to-day owners are returning to the hand treatment of all affected sheep, as originally proposed by the Bureau. The failure of dipping to give satisfactory results in all cases was probably because some sheep were actually infected before dipping and because in some cases the disease was contracted after dipping by the animals being placed in infected corrals, pens, or cars, or being driven over infected trails.

At first it was hoped that as the affected territory was limited the outbreak might be suppressed by local measures without the necessity of resorting to federal quarantine. Furthermore, the Bureau at this time had not finished its work of eradicating foot-and-mouth disease in the East and was in no position to spare either the men or the money to take up in a vigorous way the suppression of lip-and-leg ulceration in the West. As the time went on, however, and the malignant form of necrobacillosis continued to spread, it was considered best to declare a federal quarantine on sheep in eight counties in Wyoming, and this was done by the Secretary of Agriculture on August 6, 1909, to take effect August 12. This action was taken only after conference with the authorities of Wyoming and other States, and after receiving requests from those officers and from numerous sheepmen that the Bureau do what it could to check and eradicate the disease.

During the month of August, while Secretary Wilson was on a trip of observation of the Department's work in the West, he was appealed to by some of the sheepmen at Rawlins, Wyo., and he directed that I confer with them later and render whatever assistance the Bureau could give in an effort to control and eradicate the disease. A meeting was therefore held at Cheyenne on August 30, which was attended by a large number of prominent sheep raisers, and by the governor, the state board of sheep commissioners, and representatives of the state wool growers' association, as well as by several representatives of the Bureau of Animal Industry. The situation was discussed very fully as far as it was understood at that time, with reference to the best methods of combating the disease. At that time the Bureau representatives had not completed their investigations as to methods of treatment, which they had commenced only a few months before.

Following this conference another meeting was held, at which the state board of sheep commissioners, representatives of the state wool growers' association, and representatives of the Bureau of Animal

Industry were present, and a draft of the Wyoming Order No. 29 was tentatively decided upon.

As a result of these meetings, and at the request of the sheep owners, the Bureau undertook to assist in carrying out the order requiring dipping and the hand treatment of affected sheep, which at that time was thought to be the most expeditious method of dealing with the disease.

The first federal quarantine order, which took effect August 12, prohibited the interstate movement from the quarantined area of sheep affected with lip-and-leg ulceration. It permitted the interstate shipment of exposed sheep to recognized slaughtering centers for immediate slaughter without dipping, but required the dipping of exposed sheep for interstate shipment for stocking or feeding purposes. Healthy unexposed sheep were allowed to be moved interstate from the quarantined area when accompanied by a certificate of inspection by the Bureau of Animal Industry. The quarantined area was slightly changed at the request of the Wyoming board by an amendment effective September 15.

On November 22 the terms of the quarantine were somewhat altered so as to provide for a reinspection in less than seven days after inspection and dipping, and if necessary a second dipping, of sheep not diseased but which were a part of a diseased band, before they could be moved interstate for breeding purposes, and also to provide that the state or territorial officials should assume the responsibility of permitting exposed sheep to be moved without dipping for feeding purposes into their respective States or Territories.

As is always the case in enforcing quarantine measures, some inconvenience and hardship were occasioned, and there has been objection on the part of sheep owners to the stringency of the measures applied. It is impossible to enforce a quarantine in such a way as to be effective in preventing the spread of a contagious disease and at the same time to avoid hardship to stock growers and shippers.

The shipping of exposed sheep to market centers for slaughter, and the occasional receipt at such places of sheep that had developed the disease en route, resulted in many instances in great loss to the owners on account of the low prices that they were obliged to accept.

The measures prescribed by the Department were made just as lenient as they could be, considering the nature of the disease, as the Department felt that it should not make its regulations unduly oppressive and should extend every facility to sheep owners for marketing their sheep consistent with the nature of the disease and with proper sanitary precautions.

In this matter the Bureau is standing between two conflicting interests. The sheep raisers in the infected area, on the one hand, wish to have their stock let out for marketing or feeding. The

buyers and feeders in other parts of the country, on the other hand, want to be protected against the purchase of exposed sheep in which the disease afterwards develops. In this situation we have done our best to be fair to both sides. Nevertheless, complaints have been received from eastern feeders that the disease has broken out in sheep bought by them after having passed inspection, and the Bureau has been asked to make settlement for losses resulting therefrom.

The nature of the disease makes it impossible for even the most careful and expert inspector to detect the presence of the infection in all cases before it has manifested itself in actual lesions, and this fact was a strong reason for requiring not only the inspection but the dipping of all exposed sheep, or sheep which, while apparently healthy, had formed part of diseased bands.

There has been some complaint on the part of sheep owners that Bureau inspectors have held up sheep which did not have lip-and-leg ulceration, but merely had sore mouths caused by frosted grass or the coarse, rough feed of winter. It is significant, however, that sore mouths have not only been observed in grazing sheep, but have also been found in suckling lambs before they had commenced to eat herbage of any sort.

It must be remembered that necrobacillosis in all its various forms, whether mild or virulent, is an infectious disease, caused by the same germ; and further, that it is also what is known as an inoculation disease; that is, the necrosis bacillus requires for its entrance into the body an impaired or broken tissue. The effect of frosted herbage, hard wiregrass, and other similar substances is to produce wounds into which the bacillus may enter and cause disease. When sheep are injured in this way and apparently have only the mild form of sore mouth, in territory where the malignant form of the disease prevails and where the wounds are very likely to be infected with the germs, it is only a matter of a little time when the disease is likely to develop in them.

Reliable evidence has been obtained in a number of instances showing that the disease was undoubtedly contracted by healthy sheep from infected premises, and it is very probable that many outbreaks have been produced through infected trails, cars, loading chutes, etc.

With regard to the requirement of dipping, it may be said that the disinfection by dipping of sheep that have been exposed to a contagious disease of this kind before allowing them to be placed with healthy sheep is a requirement that is in entire accord with the best scientific knowledge regarding contagious diseases. The disinfection of such sheep is required for the same reason as the disinfection of harness, utensils, and equipment in a stable in which animals affected with a contagious disease have been kept; that is,

even though certain animals are not actually affected with the disease, if they have been in contact with diseased animals or infected premises, they are likely to have the virus on their wool or on their bodies in the same manner that such virus might contaminate any inanimate object that had come in contact with diseased animals.

Bearing in mind the nature of the disease, the limited information regarding its extent, and all the facts which I have stated, it is difficult to understand how any more lenient method could have been adopted by the Department of Agriculture in dealing with the disease. If it is to be controlled in any effective manner it is essential that more or less stringent measures should be taken, and the Department has endeavored to make its requirements no more strict than necessary, and to permit the movement and marketing of sheep with just as little interference as possible, consistent with effective work. We have already had complaints of eastern buyers, as before stated, that the disease was breaking out in sheep which had passed inspection.

An example of the damage caused by necrobacillosis in other species than sheep and also of the danger that would result from its spread is found in the case of the San Luis Valley of Colorado. Hog raising is an important and paying industry in that valley, but has been greatly interfered with by necrobacillosis, which has affected hogs there for several years. It seems likely that if the malignant form of necrobacillosis should become transferred to other sections where hog raising is extensive, such as the Middle West, the same disastrous results might follow.

If we are to succeed in controlling this disease, the efforts of the federal and state officers must be backed by the cooperation of the sheep raisers. If each individual flockmaster would apply effective treatment and cure the disease in his sheep and eradicate the contagion from his corrals, the disease could be sooner and more easily stamped out and the troublesome quarantine restrictions removed. Many owners have treated their sheep, but it is necessary that this should be more generally done. The disease yields to proper treatment in most cases, and effective methods of treatment have been prescribed by the Bureau of Animal Industry and by state veterinary officers. It is within the power of the sheep raisers, by cleaning up their flocks, to hasten greatly the time when the quarantine can be raised, and the Bureau earnestly desires the help and cooperation of all who are interested in bringing about that result.

Even in the case of the mild form of sore mouth as it occurs in lambs, it would be much better if the owners would keep these lambs on their ranges or premises until the disease has run its course and the lambs have become well. This would only require holding them for a few weeks longer, and they could then be sent to market in good condition and without any likelihood of being held up.

I want the stockmen of the country to realize that the object of the Bureau's work is to protect and benefit their industry, and that in all our work we always have this object plainly in view. We must look at the matter in a broad way, however, and consider the good of the live-stock industry throughout the country as a whole. It is not to be thought for a moment that a progressive nation such as ours would permit an injurious and destructive contagious disease of live stock to spread all over the country just because effective measures for its control would entail some inconvenience and hardship on the stock raisers in a limited area.

But the object of our work is not solely to protect the sections of the country where the malignant form of the disease has not spread. The interests of the sheep raisers in the infected territory demand that the disease should be controlled; and while the process may be somewhat burdensome to them for a time, the ultimate result will be greatly to their benefit. So whether we view the subject in a broad way from the standpoint of the live-stock industry of the country as a whole, or from the narrower standpoint of the interests of certain limited sections, the work of quarantine and suppression of a contagious disease can only be regarded as beneficial in the end.

In endeavoring to control and eradicate contagious diseases of animals, however, the Bureau of Animal Industry always tries to proceed in such a way as to accomplish that result with the least possible disturbance and inconvenience to the movement and marketing of live stock. We endeavor to combine scientific knowledge with practical common sense. We are always willing to listen and learn, and are glad to confer with those engaged in the live-stock industry and to carry out their wishes so far as possible. It has been very gratifying indeed for me and my assistants to be able to meet with the wool growers and the various state sanitary officers and to discuss this subject from the different viewpoints. I trust that this discussion has resulted in all of us acquiring more information on this very important subject, and that this conference will be of benefit to the sheep industry.

## II. LIP-AND-LEG ULCERATION (NECROBACILLOSIS): ITS CAUSE AND TREATMENT.

By JOHN R. MOHLER, V. M. D.,
*Chief of the Pathological Division.*

### INTRODUCTION.

For the past few years, especially during the winter season, the Bureau of Animal Industry has been appealed to on numerous occasions from various sections in the Northwest to investigate attacks of diseases affecting the sheep in these localities and to furnish aid in the treatment and eradication of these maladies. From the increasing number of letters received it was apparent that in some sections a serious condition of affairs existed and that it was not an idle appeal that had been made for help. Under a great variety of names a disease was described which seemed to point to a more or less common origin. In short, this was found to be the case when inspectors were sent into the infected regions, and what was described under so many different names was found to be in reality various manifestations of one and the same disease, namely, infections with the necrosis bacillus, a germ that was described early in the eighties by various European investigators and has since been found to be very widely scattered and the causative agent of many of the ailments which affect domestic animals. In this connection it may be stated that all the differing manifestations of the infection by the necrosis bacillus in the various species of animals are frequently brought together under the one general term—necrobacillosis.

During the work of the past year a very contagious form of sore mouth in lambs was observed, and studies as to its causation were instituted. This affection, with which every experienced sheep owner is more or less familiar, is designated by various names, such as sore mouth, sore lips, warty mouth, warty nose, impetigo labialis, ecthyma stomatitis, etc.

The disease has been observed in this country in both the East and the West as well as in various parts of Europe off and on for the past twenty years, and until quite recently little effort has been made to find the causative agent or to check its spread. European investigators are not at all in accord in attributing a cause for the malady, but that they have been working with this same sore mouth affection

is not to be doubted when one reviews the literature on the subject and reads the very accurate descriptions of the lesions found. If there were any doubts from the published descriptions they would be dissipated by the photographic illustrations that accompany the articles. Strange as it may seem, most of these writers have not definitely determined the cause of the trouble, but a small number of able investigators have good reason for incriminating the bacillus of necrosis.

It has previously been the habit of many sheep owners to ascribe the cause to coarse grass, bristle grass, shad scale, bunch grass, clover, alfalfa, beet tops, and to weaning of the lambs, to dew on the grass, to frost, and to a host of other causes. These in all probability are highly predisposing factors but not the actual cause.

The older veterinarians, before anything was known about the rôle of bacteria in the causation of disease, also held to the same opinions about the causes of disease in general, but a review of their writings shows that their opinions were only theories or guesses at the real cause. No experiments were made to prove their assertions, but, as in human medicine, many of the obscurities of disease are now being uncovered by definite, convincing, and indisputable researches.

It is a significant fact that from numerous specimens examined by the Bureau of Animal Industry last year the necrosis germ has been isolated, and inoculation both of lambs and older sheep with the diseased tissues from the lambs' mouths has produced the disease. No observing man could advisedly question its contagiousness, and from this fact alone the Bureau is bound to take some cognizance of its existence.

## HISTORY.

Some of the early writers seem to have been convinced that the disease termed lip-and-leg ulceration in this country was in no degree contagious, but at a later period many investigators opposed this opinion and strongly maintained that it spread from sheep to sheep by means of some contaminating germ.

Gilruth, of New Zealand, in 1900 reported on a disease which he termed acute facial eczema in sheep, manifested by an eruption on the face and ears of lambs. He considered it at that time to be due solely to errors of diet from eating rich feed like rape or clover. His assistant, Clayton, made an excellent report on this eruptive disease of the lips and face among a band of lambs. A large percentage were affected, the whole of the face in some cases being covered by a mass of scabs. In others the trouble was located around the mouth and nostrils only. The feet and legs were not affected, but the lambs fell off considerably in condition. In this outbreak Clayton could find nothing to account for it in the way of rape or clover, but nevertheless considered it to be dietetic. Subsequently,

in 1906, Gilruth described the appearance of a similar disease affecting the skin of the mouth and nose of sheep in New Zealand. He called it acute dermatitis of the face, and his experiment demonstrated fairly conclusively that a micro-organism was the cause. About 100 of the sheep became affected, and only a few died, not as a direct result of the disease but because of the interference with feeding and breathing induced by swelling of the skin of the lips and nostrils.

In 1907 Gilruth recorded the same disease under the term acute stomatitis affecting the lips and mouths of lambs, and found the cause to be the same germ that caused the disease the previous year among older sheep, although the actual lesions produced were somewhat different. The owner had used the pasture for five years, but previous to the outbreak no affection of the mouths or lips of any of the flock had been observed at any time. A short time after lambing the shepherd observed several lambs with what he described as scabs affecting the lips. Believing the disease to be contagious, he slaughtered and buried the first ten or twelve he found affected. Fresh cases appearing with great rapidity, he notified the chief veterinarian and requested an investigation. After the lambs were subjected to the usual operations of earmarking, castration, and docking, 50 per cent developed more or less extensive ulcerative sores on the stump of the tail, while a considerable number showed similar lesions around the earmarks. Some of these tail and ear ulcerations occurred on lambs which showed no lesions of the lips and mouth. Curiously enough, in no instance were lesions found present in the region of the scrotum after cutting, a fact the more remarkable because the disease had been transferred in many cases from the lips and mouth of affected lambs to the udder and teats of their mothers.

In 1908 Gilruth again reported upon sore lips in lambs in New Zealand. Treatment of one band under investigation was very perfunctorily carried out, and four days after the lambs were docked and castrated 7 of the lambs and 1 ewe were found dead. All the dead lambs were wethers, and in each case the scrotum was tremendously swollen, ulcerated, and gangrenous. Only a small percentage of lambs were affected with sore mouths, but nearly all showed ulceration of the tail stumps, while the scrotums of over 80 per cent of the castrated lambs were so affected as to require treatment, and the same virulent germs were found in all. Besides the lesions and deaths among the lambs there was at the same time a similar disease affecting the ewes of the same band, which occurred principally in the neighborhood of shear wounds and on the udders through contamination by the sore mouths of the lambs. It therefore seemed quite certain that the shears as well as the docking knife became contaminated with the specific germs. Gilruth in his last report states that while at first all the cases brought to his attention were confined to lambs,

he has since seen the disease among two-tooth ewes, and even older ewes. The disease was proved to be contagious by inoculating two healthy ewes.

McFadyean, in 1901, described a disease similar to lip-and-leg ulceration, which is usually met with in England as a troublesome affection of ewes and young lambs and called malignant aphtha. In the case of the lambs the disease is manifested by the formation of sores on the nose or lips, and the ewes develop similar sores on the teats and udder. The disease apparently is spread only by direct application of matter from the sores to the skin. This author states that in Scotland a disease exists among the lambs of any age, and rarely in adult sheep, known locally as orf. He states that it is not of rare occurrence, but has received little attention in veterinary literature. On the face the lesions are present on the hairy surface of the lips and around the nostrils. On the legs the sores may form anywhere between the hoof and the knee or even higher, and sometimes the sensitive structures around or between the claws are involved.

Armatage, in his English work, "The Sheep Doctor," describes a contagious ecthyma or malignant aphtha which corresponds very closely with the condition seen in the lambs in the sheep-raising sections of the Northwest. He says:

> In the lamb the disease first attacks one or both nostrils, the margins of the lips, and the front of the gums. The skin first shows an elevated portion of skin which is tender from inflammation, shortly converted into a spreading sore, and later covered by a scab which is readily removed. Similar changes are seen on the lips and gums, succeeded by a croupous covering varying considerably in size, often productive of much damage to the gums.

Berry, in 1901, reported this disease as existing in England, Scotland, and Wales, where it is known as contagious pustular dermatitis, orf, or crusta labialis, and is said to be more familiar to the shepherd than to the veterinarian. Sheep of any age seem to become infected, but it is more frequently and readily transmitted among lambs or sheep under 1 year old. In many outbreaks nearly all the sheep become infected, and diseased sheep brought into a band will transmit the disease to many of the healthy animals within a fortnight after mixing the flocks. The fatality of the disease is not great, although fluctuating from time to time.

W. Williams, in 1894, described under the term orf, or carbuncle of the coronet in sheep, a disease occurring more particularly in young sheep, but occasionally in old ones. It is characterized by lameness, inflammation of the coronet or the space between the claws, which latter develops into angry-looking ulcers. These ulcers may attain a large size, fill up with granulations, or bleed readily. Similar ulcers or sores may appear on the face and head. It is not a fatal disease, but is troublesome, and when well estab-

lished is slow to heal. Williams also used the term crusta labialis for the affection when the lesions are more marked on the face, although the eruption is seen on the coronets and pasterns as well as the lips and nostrils.

Hutyra and Marek, of Hungary, reported in 1906 the presence of pustular stomatitis in two imported bucks. Three days after they were turned in with native sheep the latter developed symptoms, and in a short time almost the entire band of 500 sheep showed eruptions and ulcers on the lips, corners of the mouth, and edge of the nostrils. The disease spread rapidly, but was in a benign form, the only two animals which died developing lesions in the lungs.

Hasenkamp, in 1908, observed numerous cases of ulcerative stomatitis in sheep of Germany which were affected with foot rot, and was able to incriminate the *Bacillus necrophorus* as the causative agent of both these conditions. In some of these sheep he observed embolic areas of necrosis in the liver and lungs as a result of secondary infection.

Moussu, of France, and Dollar, of England, describe an ulcerative stomatitis of sheep which corresponds in all particulars to the disease as seen in western lambs in the United States, but add that they have observed a mortality of 15 per cent.

Besnoit, another French writer, in 1901 gave a good description of this same ulcerative stomatitis in lambs and goats, and referred to other authors who had previously written on the same subject. The disease was formerly attributed to dirt and carelessness, but Besnoit considers it a grave and contagious malady due to a specific virulent germ.

In the work of Cadéac, published in Paris in 1908, a very good description of ulcerative stomatitis of lambs is given, and the necrosis germ is given a prominent place in the causation of this disease. The evolution of the disease is stated to be very rapid.

Leclainche and Vallée have made an unpublished observation regarding enzootic necrosis of the lips and nose of French sheep, from which they recovered the necrosis bacillus. The process advanced until in some cases it completely destroyed the lips, making the eating of feed so difficult that some deaths occurred.

Knowles, in 1907, described very fully and accurately a disease occurring among the sheep of southeastern Montana which affected the lips and legs of the animals. He was the first writer to apply the name infectious lip-and-leg ulceration to this disease, which is quite appropriate, owing to the character and location of the lesions. Knowles found the necrosis bacillus to be the cause of the lesions, and succeeded in transferring the disease from infected to healthy sheep by a series of inoculation experiments.

Craig and Bitting, in Bulletin 94 of the Indiana Agricultural Experiment Station (1903), state that young and debilitated lambs when kept under unhygienic conditions are prone to contract the ulcerative form of sore mouth. They claim that the disease is no doubt due to some of the virulent germs, as it seems to be communicated from one lamb to another.

Law, in 1900, has described, under the term ulcerative stomatitis in lambs, an enzootic affection which he says is manifestly contagious, but the infecting microbe had not then been demonstrated. A number of organisms other than the necrosis bacillus are cited as being formerly supposed to be the cause, but none of these in pure culture produced the disease.

Rushworth, in 1899, reports on aphtha or sore mouth as a very troublesome affection generally seen among sucking lambs, although older sheep sometimes are severely affected by it. Many supposed causes, such as feeding turnips, rape, etc., low vitality, unhealthy surroundings, and in aged sheep decayed teeth, have all been suggested as the cause, but the fact that the udder and teats of the ewe become affected from the lips of the lambs tends to prove its contagious nature, according to Rushworth. Apparently the lambs first become infected and the ewes are then inoculated by their lambs.

Joseph E. Wing, in his "Sheep Farming in America," describes the lamb disease under consideration as a contagious form of sore mouth, which also affects the teats and udders of the ewes. Often the sores along the edges of the lips become so troublesome as to cause the death of the lamb, more usually simply interfering with its thrift so much as sometimes to make it profitless. Wing has found that this disease often breaks out upon the mouths of western range lambs on their arrival at an eastern farm for feeding. He assumes that it is of germ origin, and therefore uses local applications of sheep dips with excellent results.

Walley, as far back as 1888, described an eruptive disease mostly seen in young sheep in England, which he termed malignant aphtha. He writes:

> I am in possession of the most indubitable proofs of the infective and contagious nature of the malady, and all our old ideas as to the disease having simply a dietetic or local origin must be relegated to that limbo where so many ideas have gone during the last decade.

Sheep breeders and shepherds are quite familiar with this sore-mouth disease of lambs and are prepared to contend with it. Probably this fact has largely tended to mislead them as to the destructive character of the malady under unfavorable conditions, and has thus been the means of materially increasing their losses through

the appearance of the more malignant and dangerous forms of this disease.

For instance, in Great Britain, while the sore mouth of lambs has been known and described for more than twenty years, the venereal form was first described in 1903 by Flook. He relates the presence of extensive eruptions about the mouth and nose and a discharge from the sheath in buck lambs. The affected bucks were placed with a small flock of old ewes, and one week after 9 of these ewes showed swelling of the vulva with raw, ulcerating sores on the skin and mucous lining of the lips of the vulva. The bucks showed ulcerating sores in the sheath, and one had eruptive lesions on the upper lip. During the same year McFadyean observed the same disease affecting the vulva of ewes with the production of swelling, ulceration, and discharge. McFadyean reproduced the disease by collecting the discharge on cotton, which was placed into the sheath of a wether. On the third day a small sore covered by a brownish scab appeared on the skin near the opening of the sheath and continued to spread around the opening. A number of small ulcers formed, covered by brownish crusts. This author did not succeed in isolating any organism which he believed caused the disease, but considers the disease worthy of careful observation, and that newly purchased bucks might well be examined for this affection before being used in breeding. G. H. Williams reported on two more outbreaks of this disease in Great Britain, affecting the genitals of bucks and ewes and similar to those recorded by the two preceding writers. One ewe also showed lesions around the nostrils. In another flock of ewes he found eruptions about the lips and nostrils only, and it was to this form of the disease that Walley gave the name contagious dermatitis.

## CHARACTER AND LESIONS.

It becomes evident, after reviewing the various above-described forms of this disease of sheep in different countries, that the characteristic lesions may be found on any part of the exterior of sheep where the bacillus which causes it may gain entrance; but cuts, bruises, abrasions, and exposure to devitalizing processes being less frequent upon parts covered with wool and their contact with infection less likely, it follows that the woolly portions of the body are less subject to lesions than other parts. In this country lesions upon the head, as lips, chin, nose, cheeks, gums, and hard palate, are the most frequent, while much less common are the ulcers on the legs and feet. Shear cuts and the tail stump of docked lambs are at times infected, while slit ears have been more frequently involved. In bucks frequently and in wethers occasionally the sheath is infected. The vulva of ewes has been found ulcerated in a relatively small percentage of cases, while the udder and teats even

more rarely have developed the infection, notwithstanding that the sucking lambs showed more or less ulceration and eruptions on the mouth parts. In some cases lesions have appeared in the pharynx and lungs, occasionally in the liver and stomach, and in such instances the disease uniformly results in death.

It may be advisable to arrange these various manifestations of the disease into the following classes, with the statement that further study is required to explain the reason for necrobacillosis in sheep assuming several different forms or types under what appears to be similar environment, as well as for the disease becoming virulently infective in certain cases, while in others, under practically the same

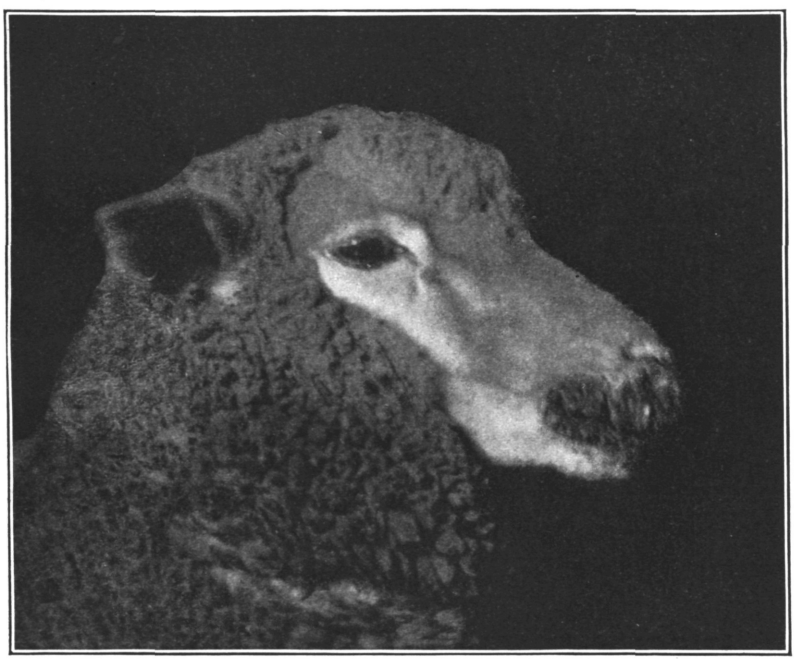

FIG. 1.—Lip-and-leg ulceration, showing lip lesions in ewe infected with germs obtained from warty lips of lamb.

conditions, there is a tendency toward latency or even spontaneous recovery.

1. The lip-and-leg form, as the name indicates, attacks the lips or legs, or both. The lesions in some bands are confined very largely to the lips and muzzle, in other bands the lesions are largely confined to the legs, while in still other bands the seat of the lesions is about equally divided between the lips and legs. This form of the disease is shown in figures 1 and 2.

The different conditions under which the sheep are kept and the character of the feed may account, in a degree at least, for this

difference in the seat of the lesions, and also to some extent for the difference in the spread of the disease, especially within the band. Thus, during the winter, when snow is on the ground and the weather

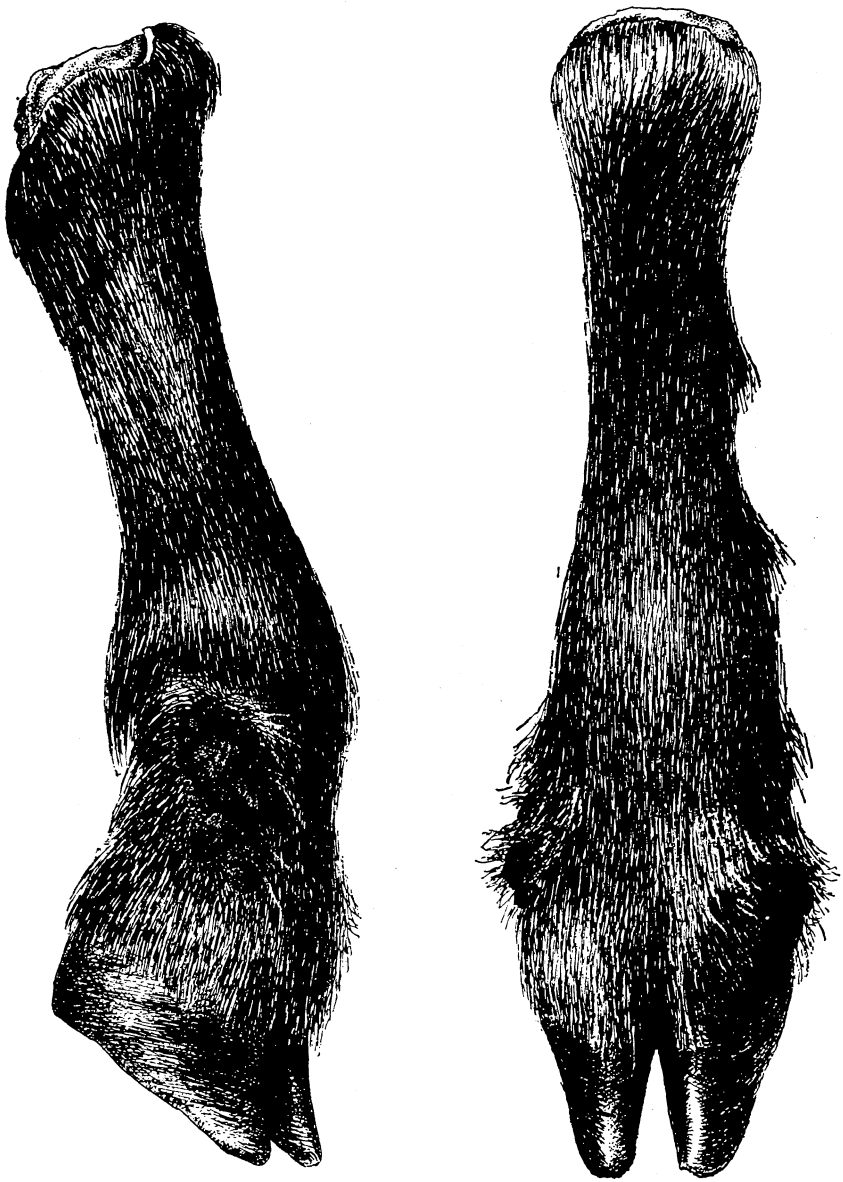

FIG. 2.—Lip-and-leg ulceration, showing leg lesions.

is so cold that the surface of the snow becomes hard and crusted, making grazing very difficult, the chances are that leg lesions would be likely to predominate, owing to the numerous scratches received

upon the legs becoming infected with the blood and bits of scab which drop from the infected sheep. On the other hand, if they were fed on a range where cactus and greasewood composed a large part of the feed, the spines of these plants would be likely to wound the lips and nose to such an extent that lip lesions would be apt to predominate. Other sheep ranging over such ground after the infected sheep had passed would under such conditions be very likely to contract the disease.

This form may assume either the active or the inactive stage. The active stage manifests itself in the various locations by inflammation, tumefaction, ulceration, and necrosis, with or without scab formation. There is more or less rapid destruction of the tissue, especially where the lesions are located on the lips or muzzle. Cases are frequently seen where more of less of the lip or the end of the nose has sloughed away as a result of the suppurative inflammation. In such lesions the predominating form of the necrosis bacillus is the long, beaded, vegetative filament located on the border of and penetrating the healthy tissue. The inactive or chronic stage is characterized by a stationary condition of the lesions, unaccompanied by tumefaction or inflammation except of a productive or proliferative character. In these cases the involution or quiescent forms of this pleomorphic bacillus, especially the bacillary and coccoid types, will be observed in the degenerated débris. The different forms of the bacillus are shown in figure 3 and its cultural characteristics in figure 4.

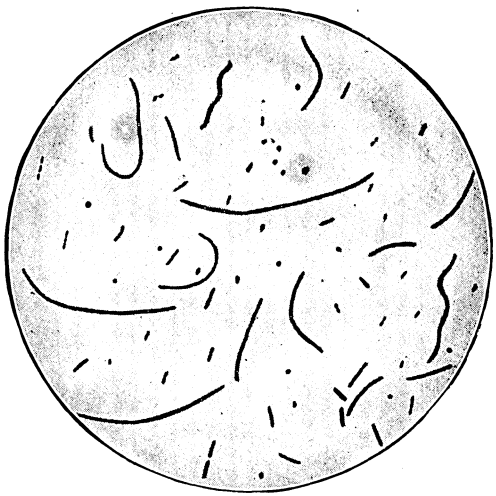

FIG. 3.—*Bacillus necrophorus* showing coccoid, bacillary, and filamentous forms.

The lesions in the early stage usually appear as an acute inflammation of the skin on the outside of the lips. This pimple-like formation is attended with much inflammatory swelling, with a decided tendency toward the formation of pustules. They dry and form crusts of a dark grayish color. The growths extend rapidly and become in the course of a few days confluent, forming a large diffused scab, which when removed is found to cover an ulcerative surface. Simultaneously with this the lips become tumefied, swelling to two or three

times their normal thickness. The appetite usually remains good, but the animals feed with difficulty, owing to the sensitiveness of the affected parts. In some cases the lesion extends from the lips up over the cheeks, occasionally involving the eyelids or even the eye itself. At times a mucopurulent nasal discharge appears, which adheres to the nostrils and together with the swollen condition of the surrounding tissues causes a more or less complete occlusion of the air passages, resulting in labored breathing upon exercise. In some cases the lesions extend into the mouth, producing erosions on the inside of the lips, on the gums, and on the dental pad of the hard palate. These lesions, which are of a spongy consistence and present a warty appearance, are especially noticed on the lambs.

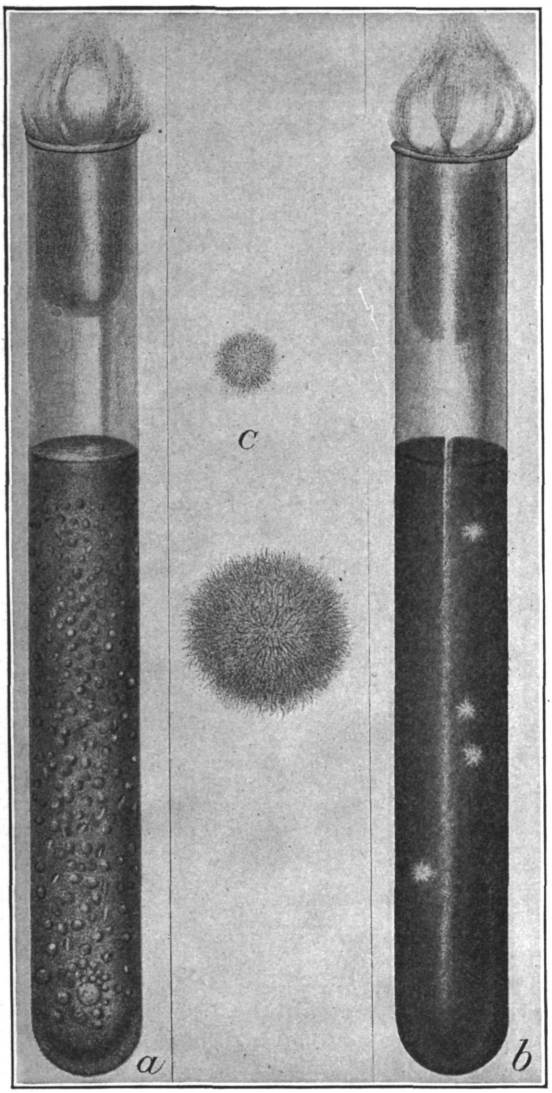


FIG. 4.—Development of colonies of *Bacillus necrophorus* in agar jelly. *a*, Culture showing twenty-four hours growth, with numerous small gas bubbles; *b*, culture seven days old showing isolated colonies which are characteristic in that their grayish centers are surrounded by fuzzy white areas not unlike the strands of loose, fleecy cotton; *c*, single colonies of the necrosis bacillus showing this filamentous character of their growth (enlarged). (From drawing by W. S. D. Haines.)

Lesions on the legs may coexist with those on the lips. The sheep at this time will show some lameness, especially if the ulcers appear about the coronet, in the fold of the fetlock, or in the vicinity of a joint. The progress and appearance of the ulcers upon the legs are identical with those upon the lips, and they are soon covered by a thick, dry

crust which when forcibly removed exposes a granulating surface covered with a tenacious pus.

2. The venereal form, as the name indicates, attacks the genital organs of both sexes. This form is frequently seen in connection with the lip-and-leg form, but it is also observed in some bands that do not present any other lesions.

In bucks the external part of the sheath is affected in most instances, and more infrequently the ulcerations are confined to the penis. The latter condition may be explained by the fact that a buck is liable during copulation to scratch or abrade the membrane covering the penis with burs, etc., in the wool of the ewe, while the sheath may become infected through the use of contaminated bed grounds. In certain sections the erroneous opinion has been held that this form of the disease is syphillis or clap and has nothing to do with lip-and-leg ulceration because it is rightly considered far worse than the latter. It is probable that this form of the disease, which is also known as ulcerated sheath and big pizzle, results in a larger death rate than all the others, and it was reported that in a number of instances quite a percentage of the band, in some cases the entire band of bucks, were destroyed as soon as the disease was discovered because so many of the bucks were rendered useless for breeding through a portion of the penis having sloughed off. Besides, this appears to be the most difficult form to treat, yet good results from treatment were obtained in many cases.

In ewes the lesions are located on the skin or mucous membrane of the vulva, on the under side of the tail, and in the perineal region. In a few cases discharges which collected at the lower angle of the vulva and in the wool adjacent to the perineal region indicated the presence of infection in the vagina.

The sheath form of the disease is characterized by an ulcerated condition of the external part of the sheath without the penis being affected, and is not infrequent among wethers. Constant saturation of the wool around the sheath with urine probably chafes the skin, allowing the entrance of bacilli from infected bed grounds, etc. The first manifestations of this form of the disease are the appearance of one or more very small pale yellow centers within the folds of the sheath at the juncture of the skin and the mucous membrance Very early there forms at each of these centers an ulcer that extends outward into the skin, but rarely inward. The ulcer or ulcers extend, and frequently coalesce, so that the entire face of the sheath is covered by a single ulcer. During the early stages, in those cases where all or a considerable portion of the face of the sheath is covered with the ulcer, the entire external portion of the sheath will be more or less inflamed and tumefied.

No case of penis infection has been observed in wethers, except a few cases that had been treated by introducing strong caustics within the sheath in contact with the penis.

While this condition has been mostly observed in wethers a year or so old, two cases of natural infection were reported in wether lambs not over four months old. (See fig. 5.)

3. The foot-rot form: Owing to the dryness of the soil of a large part of the infected section in the West, this disease probably assumes a somewhat different form from the foot rot of moist localities, though foot lesions were frequently seen in connection with the lip-and-leg forms. In several instances quite a number of sheep in the infected districts presented only foot lesions, while in other instances lesions on the feet were accompanied by ulcers on the lips. The foot lesions may first become visible either at the front or back part of the cleft, but usually the erosions make their first appearance at the heel. The inflammation rapidly penetrates beneath the horny tissue, while from the ulcerous opening there exudes a thin, purulent discharge, possessing an odor pungent and disagreeable but at the same time very characteristic. Sex or age does not appear to have any important influence on the susceptibility of the animals, as the disease manifests itself quite generally in a flock, attacking alike male and female, lambs, yearlings, and aged sheep.

FIG. 5.—Lamb with lesions on lips and sheath. (Photograph by Dr. W. E. Howe.)

4. The sore-mouth form of the disease is characterized by warty or pustular patches on the lips, covered with slightly elevated brown crusts or scabs, usually seen in lambs during the fall of the year, though it has been observed earlier in the season, both in sucking lambs and in those that had just been weaned (fig. 5).

The disease makes its appearance very quickly, the lips becoming more or less tumefied, with a slight diminution of the appetite, especially in severe cases. In some instances food is taken with difficulty, resulting in unmistakable signs of poor nutrition and the stunting of the animal. At this stage the animal presents a greater or less number of nodules or patches on the lips, most frequently at the junction of the mucous membrane and the hairy portion. In severe cases these nodules become confluent, forming large, diffuse, fissured scabs around the margin of both lips, down on the chin, or up on the nose, or both, in which case the whole muzzle is affected. The removal of these scabs exposes either a purplish-red, easily bleeding surface, or a pitted, yellowish-white ulcer covered with pus, some of which will also be found attached to the under surface of the removed crust. In very extensive lesions there may be sufficient pus so that a small quantity will exude from beneath the crust on pressure. In a few cases the disease spreads to the mucous membrane of the mouth, forming small ulcers or fungoid elevations, soft, red, and of a spongy consistence. In both corners of the mouth there are usually present small yellowish necrotic areas which are generally the last to heal. A typical, offensive odor, similar to that of Limburg cheese, is given off from the infected parts.

In some of the most extensive cases of this form there is a loss of tissue due to ulceration, resembling that seen in the lip-and-leg form. In these lesions the active, vegetative filaments will be found penetrating the healthy tissue. In unmolested cases, except probably the more extensive of this form of the disease, the crusts remain intact until the lesions are fully healed, when they drop off, leaving a clean, healthy looking surface. In such lesions the quiescent coccoid and bacillary forms of the bacillus will predominate, while only an occasional short filament will be observed.

We have positive proof of numerous cases of the malignant type of lip-and-leg ulceration developing from the lesions in sore-mouth lambs, convincing alike to the flock master and to the inspectors who had supervision over the animals.[a]

## CAUSE OF THE DISEASE.

There can be little doubt that the disease is primarily the result of abrasions of the skin and other tissues, allowing the access of the causal organism. The latter may be a natural habitant of certain localities or of certain vegetation. One factor that is predisposing

[a] The writer acknowledges his indebtedness to the veterinary inspectors of the Bureau of Animal Industry who have submitted reports on lip-and-leg ulceration, especially to Drs. John S. Buckley, George A. Johnson and Charles H. Zink.

in these cases is a prolonged drought which renders the feed scarce, inducing the sheep to browse on thistles and roughage which cause the necessary abrasions. In fact, it is frequently noted that after rains, with the consequent growth of luxuriant feed, the disease becomes checked and the affected animals rapidly recover. There seems to be some connection between dry weather, or rather very dry feed, and the appearance of the disease. While there are many factors in dry herbage liable to produce slight abrasions of the lips necessary for the entrance of germs, in succulent pastures there are few or none. However, such abrasions by themselves will not produce the disease, but when they become infected with the germs of necrosis, lip-and-leg ulceration follows. The necrosis bacillus, which is very widely distributed by nature, will not enter a healthy tissue, requiring, as it does, an abrasion, puncture, or wound through which to gain access. Of course a spine or prickle, if contaminated with these germs at the time of puncture, will act as a direct agent of introduction.

In order to obtain some information on the question as to whether the object making the abrasion is itself infected or if the wounds made by noninfected bodies become contaminated subsequently to the injury, two specimens consisting of bunch grass and shad scale were examined and inoculated into experiment animals, but with negative results. Of course these findings are in no way conclusive, merely indicating that the infection was not present on the particular specimens examined. On the other hand, tags of wool examined and tested on animals in the same manner gave positive results in two instances. The manure of sheep was also examined to ascertain if, as in hog manure, the organism exists there normally, but in no instance was the bacillus observed. In order to prove or disprove a theory that had originated in one of the infected districts, a careful study of the foot lice of sheep was made in order to determine if they played any part in the transmission of the disease, but these results were likewise negative.

There are several conditions which are responsible as predisposing factors for infection by this organism.

1. Lambs often become affected with sore mouths by coming in contact with the infectious principle. Hard, dry scabs, warty in appearance, are produced frequently, covering the entire lips, and which upon being removed leave a raw, granulated surface with or without an exudate of pus. These lesions may be present in lambs before they are weaned, in those that have been weaned, or in lambs which are forced to the range for hard dry feed after being on succulent forage. It is not, however, the feed or the pasture or the fact that they have just been weaned which of itself causes the lesions;

but in addition to these predisposing causes, the necrosis bacillus becomes present and the disease continues to spread.

2. Sheep are sometimes forced to wade through alkali gumbo mud to reach water in the lakes and reservoirs when they become low. This mud becomes matted in the hair and wool of the legs, and becoming dried by the sun and winds may be rubbed off, pulling hair and skin with it, and thus opening the way for the entrance of the necrosis bacillus followed by ulcerations on the legs.

3. In the winter time the tissues, especially of the legs and sheath, may become devitalized as a result of freezing or of frost bites, thus allowing the necrosis bacillus to gain lodgment and develop.

4. Injuries in the region of the legs and feet due to thistles, cacti, briars, bruises, etc., and wounds of the lips as a result of picking up harsh forage or frozen forage or in breaking through crusted snow for feed, provide favorable conditions for the entrance of the bacilli.

While recognizing the importance of the remote cause, it is to the proximal cause that we give credit for instituting the disease process under consideration. For instance, in lip-and-leg ulceration the proximal cause is the *Bacillus necrophorus;* the remote cause may be a puncture of the cactus. Note here that the proximal cause is invariable, the remote cause variable—for, instead of being the cactus, it may be a sharp-pointed particle of food. Again, the origin of necrotic quittor in the horse may be a nail in the foot, tread, scratches, etc. It is a variable source. But when by our investigation we find the necrosis bacillus associated with this process, we are warranted in laying hold of that micro-organism as the proximal cause—the cause which gives title to the disease process, or which, on the other hand, may receive its name from the disease. So in necrobacillosis of the intestines in calves. The immediate cause of the necrosis is the necrosis bacillus; the remote cause may be any bacterial agent capable of injuring the mucous membrane, or chemical effects connected with the feed—anything, for that matter, that could produce a catarrhal or eroded condition of the intestinal mucosa.

Lodgment in the tissues of the body of a susceptible animal is all the necrosis bacillus requires. Once this is secured where it may develop and throw out its deadly volatile toxin, all tissues with which it comes in contact become alike a prey to its necrosing action. As a result we may have necroses of the skin, muscle, hoof, cartilage, bones, mucous membrane, navel, and internal organs. In order to determine the presence or absence of the necrosis bacilli in these tissues inoculation experiments furnish an important and definite aid in diagnosis. The tissue alteration in the rabbit after inoculation with this bacillus is so characteristic as to become an essential factor in the identification of the organism. Furthermore, the work of recovering the necrosis bacillus is much simplified by the injection of

these animals, particularly if the bacilli are present in very small numbers in the specimen to be examined.[a]

## ECONOMIC IMPORTANCE OF THE DISEASE.

In considering the economic importance of this disease it is necessary to remember that many other infections are produced by this organism in many other species of animals, some of which are more grave than lip-and-leg ulceration. The presence of the latter disease on the range would indicate the possibility of the causative germ affecting other susceptible animals in any tissue in which it might find lodgment. Thus the importance of this organism is far beyond even its relation to lip-and-leg ulceration, since it affects calves, pigs, goats, adult cattle, horses, deer, rabbits, dogs, and chickens, and various forms of necrobacillosis may occur in these animals on premises contaminated with the infectious principle of this disease. Therefore, as a large majority of species of domestic animals are susceptible to this infection, and as a constant relation may exist between an attack of one form of necrobacillosis and the previous occurrence of another type of the infection in the same or another species of animal, it behooves one to prevent any susceptible animal of whatever species from coming in contact with a diseased one, or with such corrals, sheds, manure, and pastures as might be harborers of the contagion.

In whatever part of the animal body the *Bacillus necrophorus* may have instituted the inflammation which characterizes its presence, by whatever name the disease process may be called, be it foot rot, necrotic quittor, necrotic scratches necrotic vaginitis or metritis, or necrotic stomatitis, there we find a hotbed of infection and the certain groundwork of an enzootic. Hence, the occupancy of the calving stall by a cow affected with foot rot or by a cow suffering with a vaginitis dependent upon this bacillus is sufficient to insure the development of cases of necrobacillosis. The same principle is involved in the dissemination of the disease through one or more litters of pigs. The very first investigator in this line made the experiment of placing a healthy calf in a stall with two calves affected with sore mouth. The third calf came down in five days with the same malady. The author considered the calves' habit of licking one another as being chargeable with the transmission of the disease.

The proof of the transmissibility of the disease from one species to another was first secured by Dammann, who inoculated a bit

[a] For a detailed study of the bacteriology and pathology of the *Bacillus necrophorus* the reader is referred to Bulletin 67 of the Bureau of Animal Industry, entitled "Necrotic Stomatitis, with Special Reference to its Occurrence in Calves (Calf Diphtheria) and Pigs (Sore Mouth)," and to Circular 91 of the same Bureau, entitled "*Bacillus necrophorus* and its Economic Importance," both publications by Mohler and Morse, of the Pathological Division.

of necrotic material from the mouth of a calf dead with the disease into the mouth of a 4-day-old lamb. In four days the lamb died, with post-mortem findings which established the success of the experiment. Recent experiments conducted by the Bureau of Animal Industry have likewise shown that necrosis bacilli obtained from lesions of lip-and-leg ulceration will produce similar ulcers in hogs, horses, calves, and chickens which have been artificially infected by them. Moreover, cultures of the necrosis bacillus from warty lips of lambs produced ulcers on the penis of bucks, vulva of ewes, lips of old ewes (see fig. 1), and between the claws of adult sheep. On the other hand, cultures from foot rot of sheep and from the testicle of a buck produced lesions on the lips and nostrils of lambs, while bacilli recovered from the liver of a cow caused ulcerations on the lips and mouth of an adult sheep.[a]

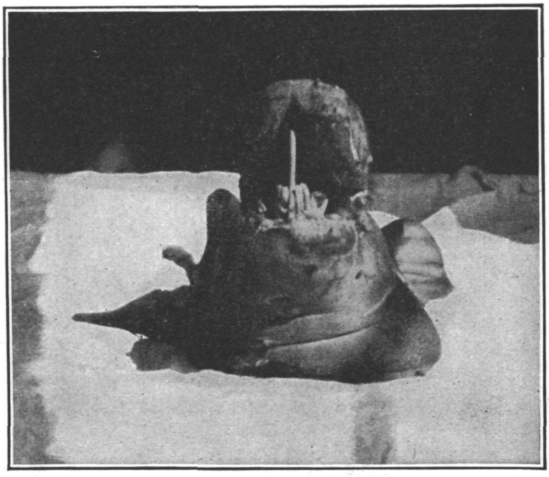

FIG. 6.—Head of hog affected with necrotic stomatitis due to the necrosis bacillus. The lower lip has sloughed away, exposing the teeth. (Sheep placed on an eastern farm where losses from this disease in hogs had occurred developed lip-and-leg ulceration three weeks after their arrival. (Photograph by Dr. Herman Busman.)

That this transmission of the *Bacillus necrophorus* from one species of animal to another occurs under natural conditions is amply demonstrated not only by the observations and experiments of this Bureau, but also by the recorded cases of other observers, both American and foreign. Law, in his work on "Veterinary Medicine" (second edition, vol. 4, p. 691), maintains that such transmission is impossible, and also leaves the impression that this bacillus is not transmissible from one organ to another organ of the same species, but these statements are entirely contrary to the experience of those who have observed the disease. (See figs. 6 and 7.)

On account of the possibility of the wide dissemination of this disease, the loss in condition of the affected animals, the stunting of growth or "setting" of the lambs, and the cost, time, and labor of treating the disease in an affected band, it is evident that the importance of the infection has not been overestimated. Fortunately, if

[a] In these investigations the writer has been ably assisted by Dr. Jacob Traum, of the Pathological Division, to whom he extends thanks.

taken in time, the disease in the vast majority of cases responds readily to treatment, the principal requisite being vigilance on the part of the herder to cut out as soon as they occur all cases of the infection, which should be placed in the hospital band for hand treatment.

The losses have varied considerably in the different States and sections. One company lost 3,000, or 10 per cent, in 1909; another lost 700 out of 2,000 old sheep, besides a shrinkage in the lamb crop due to abortion; while still another flock master placed his loss at

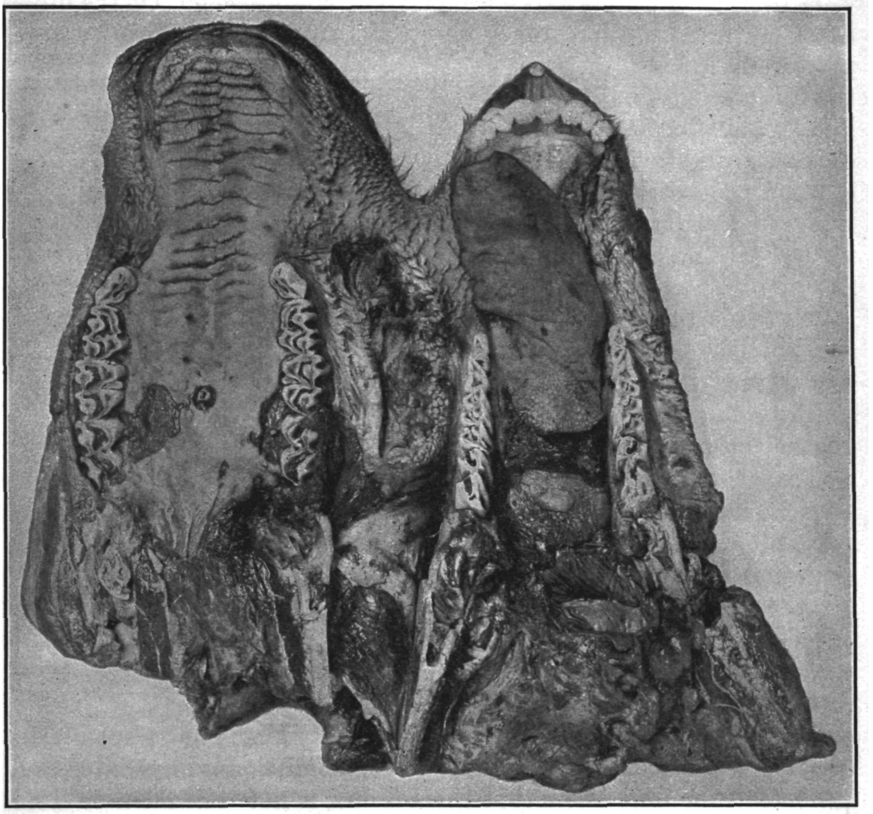

FIG. 7.—Lesions on the tongue, cheek, and hard palate in calf diphtheria, due to the necrosis bacillus. (This calf with 18 others became infected by being placed in a corral where sheep with lip-and-leg ulceration had been. Other calves from the same herd placed on another part of the ranch remained healthy.) (Photograph by Dr. Harvey B. Hood.)

$15,000 from the effects of the disease. Bucks, more valuable in proportion to numbers, are lost to service or become the greatest menace to uninfected bands. Segregation of the infected sheep, of no great consequence in a dry band, when attempted in a lamb-and-ewe band means separation of the old from the young, resulting in the "bumming" of numerous lambs in the band and a consequent financial loss. Flock masters who have experienced an active attack of this disease in their lambs realize its importance and the necessity

for drastic measures in holding the disease in check. Other owners, whose sheep have had only a mild attack, scout the seriousness of the disease but may yet learn of its devastating tendency under unfavorable conditions. It is evident that sheep are affected but mildly under favorable climatic conditions and with abundant nutritious feed. When thus affected the animal may quickly and even spontaneously recover. But in fall and winter, when bad weather and poor feed tend to lower the powers of resistance, the disease quickly makes great headway with a greater relative virulence, and in consequence a certain number of animals become so badly affected that no hope of cure at a reasonable cost or in a reasonable time may be entertained.

## TREATMENT.

In prevention lies the most important means of keeping the band clean; in treatment lies the only means of making a diseased band healthy.

Starting with a clean flock of sheep and wishing to introduce new blood into the band, a quarantine of two weeks is advisable; then, if no case of the disease has made its appearance, it will be safe to place the newly arrived sheep with the rest of the flock. A very careful examination of all sheep, especially those intended for breeding purposes, should be made, and in the event of finding any infected sheep in the band these should be cut out, thrown into a hospital band, and treated at once, keeping very close watch on the flock for any new cases that may develop later.

Prevention should therefore be carried out along three lines: (1) Separation of the sick from the healthy animals; (2) close scrutiny of the sheep that have been exposed to infection by contact with affected animals or premises, or otherwise; (3) complete disinfection of all pens, corrals, and sheds, as the necrosis bacilli will retain their virulence under favorable conditions in and around the sheepfold for several years. The walls, racks, and troughs should be sprinkled with a 5 per cent solution of sheep dip or other similar disinfectant. The manure and a portion of the surface soil of the corral should be removed and the ground sprinkled with the disinfectant solution. If possible, the healthy sheep should be taken to new and uninfected bed grounds and pastured on uninfected range. Experience has shown that sound sheep may be safely pastured on land that has been previously occupied by animals suffering from lip-and-leg ulceration if a winter's frosts have been allowed to intervene. The germs of the disease seem to be subdued effectively by this means, and pastures which have become contaminated in one season may be considered safe for their customary usage during the following season. However, the impossibility of changing range in many cases, in some not even temporarily, makes quick eradication the more difficult.

The treatment of these affections occasioned by the presence of necrosis organisms, no matter how many varieties of the disease may make their appearance, can be reduced to a few words, namely, disinfection and cleanliness, or disinfection and prevention. While selecting treatment for that portion of the flock in which the disease has become actually established it should be remembered that the principal requisite is to expose properly the affected surfaces in order that the applied remedy may destroy the infectious matter which has lodged upon them. The remedy which will accomplish this most readily and at the same time without giving rise to harmful secondary conditions is evidently the one that should be given preference.

Treatment of this disease by local antiseptics is very satisfactory if begun in time and applied energetically. It should not be deferred, as better results will be obtained by attacking the outbreak as soon as discovered than can be expected if the disease is permitted to spread among the band or penetrate deeper into the tissues of the affected parts.

In mild, unadvanced cases of the lip and leg form the best results are obtained by removing entirely the scabs and shreds of tissue from the diseased areas by means of a piece of wood sharpened to the proper angle, and applying three or four times weekly a solution of one of the cresol or coal-tar dips, or, what is far better, an emollient dressing containing 5 parts of one of these dips, 10 parts of sublimed sulphur, and 100 parts of mutton tallow, vaseline, or lard. In fact, this form of the disease responds quickly to any of the common antiseptic solutions, and it is astonishing how speedily the majority of these cases improve after careful hand treatment.

In actively progressive cases or in aggravated, chronic forms it is desirable to remove the scabs, scrape all the soft, spongy tissue from the ulcers, and touch the affected area with a 10 per cent solution of zinc chlorid or nitric acid in the strength of 1 part to 7 parts of water. Many other remedies have been tried with more or less success, but these two solutions have given the most beneficial results. As these solutions are quite penetrating and extremely caustic in the above strength, they should be handled very carefully and applied to the diseased parts only. Unfortunately, many have used an excessive amount of these very irritating solutions on the principle that if a little is good, more is better. A pointed stick, covered at its point with a piece of cloth or a tag of wool, will answer nicely for making the application of the solution. After using either of these solutions, the subsequent treatment should consist of three applications weekly of the previously mentioned emollient dressing, which is antiseptic but not caustic.

Care must be taken with these caustic solutions, as it is possible to do more harm than good if they are carelessly applied. In fact, the

indiscriminate use of strong caustics or the drastic scraping of the ulcers with a sharp knife is detrimental rather than beneficial, as in both cases harm has been done in exposing fresh unprotected surfaces to reinfection.

While a cure of the majority of the chronic and severe cases may be accomplished with four or five weeks of this treatment, the expense of any treatment applied to the small percentage of these cases which resist this method of handling will usually amount to more than the value of the animal when recovered. Therefore, when the number of old cases in the band is small, and the lesions deep, long standing, and resistant to treatment, their destruction is recommended.

Where large numbers of sheep under range conditions become affected and all require hand treatment, the problem is a difficult one. Should the disease attack a large number of animals on the legs and feet, and hand treatment is impracticable, the ulcers may be best treated by causing the affected sheep to pass three times weekly through a shallow trough containing a 5 per cent solution of any of the recognized sheep dips, but care must be taken to insure the fluid coming in direct contact with the sore parts. Those badly infected cases which show a tendency to resist treatment should be hand treated and the affected parts curetted and properly drained. If the lesions are on the coronary band or hoof, all the diseased or loosened portions should be removed with the knife. As in everything else, diligence and careful attention are necessary for successful results in these stubborn cases.

Treatment of the venereal form especially demands this careful handling. The penis of the bucks, if found diseased, should be forced out of the sheath and the necrotic patches cautiously cauterized with the zinc chlorid or nitric acid solution previously mentioned, and dressed daily by injecting a 1 per cent sheep-dip solution, a 1 to 500 permanganate of potash solution, or a 25 per cent solution of peroxid of hydrogen into the sheath until cured. If the penis or inner part of the sheath is extremely ulcerated and the prospects of cure is not favorable in a reasonable time the animal should be killed. Lesions on the external part of the sheath are treated like similar lesions on the lips and legs. All the tags of filthy wool should be removed, and if the lesions are mild, treat with mild antiseptics every two or three days; if severe or chronic, cauterize first and then dress with mild antiseptics three times weekly. Care must be observed, however, not to overdo the cauterization on this part, as closure of the orifice of the sheath is liable to occur as a result of too vigorous treatment, and a severe inflammation and swelling of these parts may take place. The same strength injections of sheep dip, peroxid of hydrogen, or potassium permanganate, as above mentioned, may be used in the vagina of the

ewes, and the external lesions treated the same way as those on the sheaths of the bucks and wethers.

At times an infection with the necrosis germ is seen in the form of abscesses containing semisolid pus and spoken of by shepherds as boils. These are very easily cured by opening them with a knife, cleaning out the pus, and applying the disinfectant and antiseptic solutions already referred to.

The warty lip form of this disease, as already mentioned, runs a course to recovery under favorable conditions in about three to four weeks, but medicinal treatment will materially aid recovery and prevent some of the cases from becoming malignant or chronic with more or less loss of tissue from ulceration. The application of lard, mutton tallow, or vaseline containing 5 per cent of a recognized sheep dip has been very beneficial after rubbing off the scabs and crusts that form around the margins of the lips and nostrils. The necrosis germ being one which thrives best without oxygen, exposure to the atmosphere will of itself prove beneficial. Pure strength coal-tar dips, peroxid of hydrogen, tincture of iodin, and 1 per cent pyoktannin have all been found efficient, but the milder remedy just before recommended has given the best results. The lesions of the lining membrane of the mouth, which sometimes accompany this disease of lambs, may be satisfactorily treated by washing the mouth with a 2 per cent chlorate of potash solution, a 3 per cent boric acid solution, or a 1 per cent creolin solution.

The German treatment, which the writer has not yet tried because it has just been published, consists in the application of 1 part of creosote and 50 parts of cod-liver, linseed, or castor oil externally, and the administration of 1 tablespoonful of this mixture internally to each lamb twice daily.

As an aid to treatment, as well as a preventive measure, it would be advisable to feed to the sheep salt which contains either sulphur in the proportion of 1 part to 12, or crude carbolic acid 1 part to 100—that is, about 4 ounces of crude carbolic acid poured upon 12 quarts of ordinary barrel salt and thoroughly mixed.

After the affected sheep have received local treatment and recovered they should be dipped in one of the recognized sheep dips prior to being turned upon uninfected pastures or premises. Recent developments strongly indicate that much territory is infected, and it is difficult to assert that any given range is entirely clean upon which to run the sheep after dipping. While the dips may destroy unprotected bacilli on the body of the sheep, they have less effect upon those germs which are protected by the grease, dirt, and yolk of the wool. Again, it is often difficult to find all infected animals within the band, and the disease appearing in them following dipping reflects unfairly upon the effects of the dip. Certain sheep-dip preparations

do not properly emulsify in alkali water, which is the only kind available in many sections, and the results from such dips are not as efficient as they should be. However, one dipping of these recovered cases must be considered from our present view point as a necessary precautionary measure.

In conclusion, it is my opinion that the place to suppress this disease is on the range, and if much inconvenience and financial loss is to be avoided in making shipments to noninfected States the individual flock master must battle with it at home, holding back all diseased or recently exposed sheep and shipping only those which remain healthy after they have been removed from infection for at least two weeks.

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